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News Briefs

General Developments

Inquiries about News Briefs, where no contact person is identified, should be referred to the Managing Editor, Journal of Research, National Institute of Standards and Technology, Building 101, Room E215, Gaithersburg, MD 20899-2500; telephone: (301) 975-3577.

WANTED: MEASUREMENTS WITH GOOD REFERENCES

In nearly all types of activities-be they related to manufacturing, finance, health, regulatory affairs or even sports-people and organizations are becoming sticklers for measurement uncertainty.

NIST, the nation's measurement authority, has responded to this growing customer need for demonstrable uncertainty. It has created an on-line resource—www.nist.gov/traceability—devoted to matters pertaining to the integrally related topic of measurement traceability—whether the result of a specific measurement can be related to accepted international or national standards through an unbroken chain of comparisons.

Factors driving the growth of traceability requirements include increasing world trade, growing reliance on laboratory accreditation as a means of assuring confidence in calibration and test reports, the continuing spread of quality standards and, in some technology areas, a proliferation of regulations.

At the new web site, visitors can read the NIST policy on traceability. They also can review, among other resources, a glossary of terms, answers to an extensive set of frequently asked questions on traceability, examples of relevant NIST measurement programs, and a traceability checklist for users of calibration services.

To learn more, visit the NIST traceability web site at www.nist.gov/traceability. For technical information, contact Mary Saunders, NIST Global Standards Program, (301) 975-2396, mhs@nist.gov.

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NEW NIST PRACTICE GUIDE ON ROCKWELL HARDNESS TESTING AVAILABLE

The *NIST Recommended Practice Guide: Rockwell Hardness Measurement of Metallic Materials* (NIST Special Publication 960-5)—the latest in the new practice guide publication series—is now available. Rockwell is a method-based test primarily used by metals and metal products producers to measure the hardness of metal parts, such as those found in aircraft and automobiles. The new guide is aimed at promoting accuracy and consistency in test results in the laboratory and on the production floor.

Offering good practice recommendations, the guide highlights the causes of variability in test results. To help machine operators avoid errors, the guide covers common problems, such as using the correct Rockwell scale, surface preparation, speed of testing, machine verification and environmental factors.

As part of its Rockwell hardness standardization program, NIST has developed standard reference material (SRM) test blocks for the Rockwell C scale, which is used for hard metals, primarily steel. The SRMs are used to calibrate commercial hardness machines. Researchers are working on SRMs for the B scale softer metals, such as aluminum, bronze, copper and brass. NIST also is involved with the American Society for Testing and Materials, the International Standards Organization and the International Committee of Weights and Measures in developing an international reference standard.

Responding to a related industry problem, NIST has established a microform calibration system for measuring the geometry of diamond indenters with high accuracy.

To obtain a copy of NIST SP 960-5, contact Public Inquiries, (301) 975-NIST (6478), inquiries@nist.gov. For more information on NIST's Rockwell hardness research, contact Sam Low, (301) 975-5089, samuel.low@nist.gov. The contact for NIST's diamond indenter calibration effort is John Song, (301) 975-3799, song@nist.gov.

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WANT SKILLS IN NEUTRON SPECTROSCOPY? GO TO SUMMER SCHOOL!

In June 2001, the NIST Center for Neutron Research (NCNR) conducted its seventh annual summer school geared for students at the graduate level. Partially funded by the National Science Foundation, this year's course focused on the methods and applications of low-energy neutron spectroscopy, an experimental technique widely used to study the motion of atoms, molecules and magnetic moments in a variety of condensed matter systems (mostly solids). The emphasis was on scattering methods that employ long-wavelength neutrons to achieve high-energy resolution.

Students performed a variety of hands-on experiments using five of NCNR's state-of-the-art neutron scattering instruments: the disk-chopper time-of-flight spectrometer, the filter-analyzer spectrometer, the high-flux backscattering spectrometer, the neutron spin-echo spectrometer, and the spin-polarized inelastic neutron scattering spectrometer. Each device is unique in the United States. For each instrument, students learned the scientific motivation for the measurements, how the instrument works, how to mount samples, how to set up the instrument to collect data, and how to visualize and analyze the data.

NCNR's neutron source is operated as a national user facility open to guest researchers from universities, private industry and other government laboratories in the United States and abroad.

For more information on NCNR's summer school, contact John Copley, (301) 975-5133; john.copley@nist.gov, or Peter Gehring, (301) 975-3946; peter.gehring@nist.gov. The summer school's web site is www.ncnr.nist.gov/staff/john/ss01.html.

Information on the NCNR can be found at www.ncnr.nist.gov.

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SEMICONDUCTOR LABS PUT NEW NIST SOFTWARE THROUGH ITS PACES

Forty semiconductor industry laboratories that require accurate measurements of the concentration and distribution of dopant atoms within nanometer-scale devices are field testing a beta version of NIST's new FASTC2D ("fast capacitance to dopant" level) software. The software provides an essential link between qualitative images captured by a scanning capacitance microscope (known as an SCM) and quantitative data required to design transistors for future integrated circuits.

Dopants are like a seasoning within semiconductor devices. The distribution of dopants controls how a transistor works. To control the flow of electrons to the levels required in modern circuits, engineers must know the precise distribution of dopants, with a spatial resolution better than 10 nanometers.

SCMs are strong candidates for achieving target levels of precision and resolution. Therefore, the International Technology Road Map for Semiconductors has identified them as a critical measurement tool for continued miniaturization of semiconductors.

Capacitance—a measure of electrical charge-storing capacity—also could benefit from the use of SCMs. The SCM senses capacitance between the doped region and a sharp tip positioned close to the surface of a cross section cut through the transistor structure. However, details of the resulting image have resisted accurate interpretation.

The FASTC2D computer software transforms pixel data from an SCM image into a map that accurately shows the distribution of dopant atoms. NIST researchers developed the underlying theory and later packaged it into software suitable for manufacturing engineers. Designed to run on a desktop computer, the software features a user-friendly graphical interface. It also produces highly accurate results achieved with models based on principles of physics that translate capacitance into two- or three-dimensional quantitative data on dopant concentrations.

NIST is improving the software based on responses from the 40 laboratories and plans to publish a new version and a user's guide to the software. Both the software and the guide will be available via NIST's World Wide Web site.

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NEW PUBLICATION SHOWCASES KEY NIST RESEARCH ACHIEVEMENTS

As part of NIST's 100th birthday celebration, the agency has published a retrospective of the pivotal scientific and technical papers that marked its most significant contributions to science, technology, the economic growth of the nation and a better quality of life for all Americans. *A Century of Excellence in Measurements, Standards and Technology: A Chronicle of Selected NBS/NIST Publications 1901-2000* (NIST Special Publication 958) is now available on the World Wide Web via the NIST Centennial site, www.100.nist.gov.

This book, which consists of vignettes describing some of the classic publications from NIST's first century, features titles such as "Development of the Visual-Type Airway Radio-Beacon System" (telling about the NIST system which made possible the first "blind" landing of an aircraft using radio signals in 1931); "Reversal of the Parity Conservation Law in Nuclear Physics" (recounting the 1956 experiment that shattered a fundamental concept of nuclear physics universally accepted for 30 years previously); "The Topografiner: An Instrument for Measuring Surface Microtopography" (recognizing the 1972 development of the world's first scanning probe microscope); "HAZARD I: Software for Fire Hazard Assessment" (describing one of the first fire simulation models for personal computers in 1989); "Observation of Atoms Laser-Cooled Below the Doppler Limit" (chronicling the research that led to NIST's William Phillips sharing the 1997 Nobel Prize in Physics); and "Bose-Einstein Condensation in a Dilute Atomic Vapor" (detailing the research that led to the first observation of a new state of matter in 1995).

NIST SP 958 will be available in hard copy at a future date from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161, (800) 553-6847. Ask for order No. PB 2000-107702.
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PAPER DESCRIBES NEW SYSTEM FOR DETECTING CONCEALED WEAPONS

NIST scientists are developing a system for detecting concealed weapons that could be mounted on a vehicle. Driven into a crowd, the system would scan members and identify guns, knives and other dangerous objects hidden under clothing.

The approach combines the chief advantages of both active and passive detection systems into one unit. The active part involves the illumination of a subject with a millimeter-wave source and then detecting the radiation reflected from it. Because the NIST system uses bolometers (devices that detect and measure small amounts of radiation), it is a significantly more powerful detection tool than conventional passive imaging systems.

On the other hand, the NIST system is relatively broadband so it eliminates the problem of glint often associated with active detection systems. Glint is produced by uncontrolled standing waves generated between the target and its environment. To obtain a large bandwidth, the developers use high power oscillators that operate at 95 GHz in a pulsed mode. These are commercially available at a low-enough price that does not impact the overall system cost.

The detection portion of the system is centered on a focal plane array of uncooled, millimeter-wave bolometers. The array consists of a 75 mm diameter silicon wafer populated by a 117-element array of thin-film niobium bolometers, each of which is coupled to the incident radiation by a planar, lithographically fabricated, millimeter-wave antenna.

For a copy of paper no. 12-01 describing this system, contact Sarabeth Harris, NIST, MC104, Boulder, CO 80305-3328; (303) 497-3237; sarabeth@boulder.nist.gov.
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NEW INTERNATIONAL STANDARDS ACTIVITY IN POLYMER MASS SPECTROMETRY

A new technical working area—TWA 28—in quantitative mass spectroscopy of synthetic polymers has been formed within the Versailles Project on Advanced Materials and Standards (known as VAMAS) to explore the development of a standard method for determining the molecular mass distribution of synthetic polymers (plastics).

With recent advances in mass spectrometry, it is now possible to measure the molecular mass of some biological and synthetic polymers. The distribution of the molecular chain lengths—the number of small and long ones—affects the processing of materials and the properties of the final product. The first step is to identify the mixture of chains. A variation of time-of-flight (refererred to as ToF) mass spectrometry called matrix assisted laser desorption ionization (MALDI) has the potential to be an absolute method for measuring the molecular mass of polymers. MALDI ToF mass spectrometry uses laser ablation to produce charged polymers in the vapor state, which allows the direct measurement of the mass distribution.

The VAMAS activity brings together leading laboratories in Japan, Germany, Italy, Canada and the United States in a collaborative research project that will develop the test protocols and establish the systematic measurement uncertainties of the MALDI method. NIST is chairing the new working area.

For more information on the new VAMAS activity, contact NIST's Charles Guttman, chair of TWA 28, at (301) 975-6729; charles.guttman@nist.gov.
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NIST SAYS "MORE ATTENTION MUST BE PAID TO REPAIR WELDS"

A new paper from NIST suggests that more attention must be paid to weld repairs in order to avoid failures due to problems such as stress-corrosion cracking. Even at the outset, a welded joint has a higher risk of failure from degradation of base material near the weld because of the welding process itself. This risk of failure is increased if repair welding is performed.

"Therefore, the welding, quality control and quality assurance technologies need to be developed to more stringent requirements if we want to avoid the conditions for failure, and so achieve higher reliability for welded construction," reads the report. The paper discusses possible difficulties that could occur during repair welding of high-strength steel used to manufacture pressure vessels for the storage and transport of liquefied gases. The crux of these problems is the complex temperature variations that occur during the welding repair which "can cause significant degradation of the welded-joint zone."

Repair welds are usually short, so their temperature fields are more complex than long welds. The degradation is most severe at weld starts and stops, but also can occur at other locations along the weld and for different stress conditions. Much of the report concerns degradation in properties at the weld starts and stops.

For a copy of paper No. 18-01, contact Sarabeth Harris, NIST, MC104, Boulder, CO 80305-3328; (303) 497-3237; sarabeth@boulder.nist.gov.
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NIST CONTRIBUTES TO NEW ANSI STANDARD FOR FINANCIAL SERVICES INDUSTRY

The American National Standards Institute (ANSI) recently approved ANSI X9.42-2001, Public Key Cryptography For the Financial Services Industry: Agreement of Symmetric Keys Using Discrete Logarithm Cryptography, as an ANSI standard. NIST's role in producing the standard involved coordinating the development of the standard and serving as primary editor. The X9.42-2001 standard defines the secure establishment of cryptographic data for the keying of symmetrically keyed algorithms (e.g., Triple Data Encryption Algorithm [TDEA]). Schemes are provided for the agreement of symmetric keys using Diffie-Hellman and MQV algorithms.

The Diffie-Hellman key agreement mechanism is a well-understood and widely implemented public key technique that facilitates cost-effective cryptographic key agreement across modern distributed electronic networks such as the Internet. The MQV algorithm is a variation of the Diffie-Hellman algorithm that has more security attributes and may provide better performance over analogous Diffie-Hellman methods. Because the Diffie-Hellman and the MQV techniques are based on the same fundamental mathematics as the Digital Signature Algorithm (DSA), additional efficiencies and functionality may be obtained by combining these and other cryptographic techniques.

The standard divides the key agreement process into the following major components: domain parameter generation, domain parameter validation, key pair generation, public key validation, shared secret value calculation, key derivation, and test message authentication code computation for discrete logarithm problem-based key agreement schemes. Using these components, different parties may establish a piece of common shared secret information such as cryptographic keys. The shared secret information may be used with symmetrically keyed algorithms to provide confidentiality, authentication, and data integrity services for financial information or used as a key-encrypting key with other ANSI X9 key management protocols.

Currently, NIST is developing guidelines for validating implementations of ANSI X9.42. These validation tests are designed to address the individual components of ANSI X9.42. ITL will write both a document and the software to perform these validation tests for the different components of ANSI X9.42.
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NIST RESEARCHERS LEAD DEVELOPMENT OF STANDARDS FOR WIRELESS PERSONAL AREA NETWORKS

A growing number of industry groups are developing specifications for Wireless Personal Area Networks (WPAN), such as the specifications developed by the Bluetooth Special Interest Group (SIG), HomeRF, and IEEE 802.15. WPANs, essentially cable replacement technologies, allow closely located digital devices to exchange information. Most technologies considered for WPANs employ an unlicensed radio frequency band in the range of 2.4 GHz (the so-called industrial, scientific, and medical, or ISM, band). This same frequency range also is used by existing standards for wireless local area networks (WLAN), for example IEEE 802.11. As the number of technologies using the ISM band increases, concern arises about the possibly deleterious effects of mutual electromagnetic interference.

Designing wireless protocols that can share this scarce spectrum presents a key challenge in the design of WPANs.

A team of NIST researchers made significant contributions to industry's ongoing efforts to standardize WPAN technology in the IEEE 802.15. Specific contributions include: (1) modeling and validation of the Bluetooth protocol specifications, (2) assessment of interference among wireless devices operating in the 2.4 GHz band, and (3) development and evaluation of coexistence mechanisms for wireless devices sharing the same spectrum.

NIST researchers led efforts within the IEEE 802.15 Task Group on Coexistence to study, characterize, and quantify the radio-frequency interference between Bluetooth and the now widely deployed IEEE 802.11b WLAN devices. Further, NIST researchers have proposed mechanisms and technical solutions to allow these devices, emitting radio frequency energy in the same 2.4 GHz frequency band, to coexist and operate effectively when in close proximity. Proposed solutions from the NIST researchers, for both the Medium Access Control (MAC) and Physical (PHY) layers, were combined with contributions by private companies and then adopted by the IEEE 802.15 as the basis for a document on recommended practices for device designers.

In another contribution, NIST researchers used a formal specification technique, known as the Specification and Description Language (SDL), to model and validate the Bluetooth protocols for link control and MAC. Using these models, numerous flaws in the original protocol specifications were identified, resulting in hundreds of suggestions for improvement to the Bluetooth specifications. These SDL models, created by NIST, will be published as part of the official 802.15 specifications, significantly clarifying the intent of the standard and thereby improving its testability.

Due to the growing importance of the scarce unlicensed wireless spectrum, NIST's work continues within the IEEE 802.15 Task Group on Coexistence. The NIST team continues to lead industry work in this area, concentrating on modeling the MAC and the PHY layers. The studies published by NIST on the interference between various technologies under different data traffic conditions and deployment scenarios have contributed to the task group's bimonthly meetings and presented in several professional conferences. NIST researchers also serve as editors of the Recommended Practices document on the coexistence of various wireless devices in the 2.4 GHz band. IEEE 802.15 is expected to release this document later this year.

Beyond the IEEE 802.15, NIST is working with other industry partners to further disseminate relevant technical results.

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NIST RECOMMENDED PRACTICE GUIDE "SURGES HAPPEN!" EXPLAINS PROTECTION OF CONSUMER APPLIANCES

As part of the new series of "NIST Recommended Practices Guides," a 20-page booklet has been developed for the general public on how to protect residential appliances and consumer electronics against power surges. The booklet, NIST Special Publication 960-6, is entitled "Surges Happen!"

Surges are momentary events in which the electrical power exceeds the normal levels, often with devastating results. They occur in electric power distribution networks during normal operation and during electrical storms. These menacing surges can end up in residential wiring systems where they can damage expensive electronics like computers, television sets, and VCRs, but even worse, they may cause house fires.

Written in easy-to-understand language, "Surges Happen!" explains what surges are, how they affect appliances, and how to obtain the most effective protection with readily available surge protectors. This layman's booklet also discusses sensitive equipment, provides answers to common questions, and gives some installation hints for both the home owners and electricians. "Surges Happen!" does not rate products in terms of their susceptibility to power surges but instead explains the whys and hows of surges. There has been considerable interest in this guide, which is co-sponsored by an insurance company and the electric power industry. After incorporating comments from many industry experts, "Surges Happen!" is now being distributed to relevant professional groups, such as the IEEE Surge Protective Devices Committee, and to the general public. It is available at www.nist.gov/public_affairs/practiceguides/surgesfnl.pdf.

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A WEB-BASED FACILITY FOR EVALUATING PEAK-FITTING METHODS IN X-RAY PHOTOELECTRON SPECTROSCOPY

X-ray photoelectron spectroscopy (XPS) is the most commonly used technique for determining the chemical composition of surfaces. It is customary to fit analytical functions to overlapping peaks in a measured spectrum

to determine peak positions, which identify the chemical state, and peak intensities, which quantify the surface composition. Thus, the reliability of various peak-fitting methods for XPS quantification, such as fitting different non-linear functions, is of interest to the XPS community. In addition, analysts should know how reliably they are employing a particular peak analysis method from the uncertainties associated with operator choices such as the type of background function used in their fits.

NIST researchers recently developed a web-based facility to help analysts determine the veracity of peak-fitting approaches in XPS. The NIST researchers had earlier prepared simulated spectra, based on a factorial design that consisted mainly of overlapping doublets for carbon 1*s* photoelectrons from polymers. An international group of 20 surface analysts fitted variations of Gaussian or Gaussian-Lorentzian functions to the doublets. Their results were analyzed at NIST to yield measures of bias and random error in the peak positions and intensities for each doublet spectrum in the factorial design. These error measures were analyzed further with respect to seven peak-fitting methods used by the analysts. A statistical analysis of the errors showed that some peak-fitting methods are more accurate and precise than others depending on the extent of overlap between peaks in the spectrum and the relative heights of the peaks.

Users of the NIST web site (www.acg.nist.gov/std) can analyze the simulated spectra and then assess their results for their chosen peak-fitting approach as it matches one of the seven peak-fitting methods used previously. Analysts enter the peak parameters from their own fits at the web site, and then receive an on-line analysis of their results in terms of bias and random error. They then can compare their errors with statistics for the subgroup of the 20 analysts who employed the same peak-fitting method.

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SYSTEMATIC UNCERTAINTY IDENTIFIED IN MEASUREMENTS OF SILICON DIOXIDE FILM THICKNESSES BY X-RAY PHOTOELECTRON SPECTROSCOPY

Silicon dioxide is currently used as a gate dielectric material in the semiconductor industry, and it is considered necessary to measure oxide film thicknesses between 1.0 nm and 2.5 nm with a relative uncertainty (3σ) of ± 4 %. Many techniques have been used for such thickness measurements but the results can disagree by more than a factor of two in this thickness range. These disagreements are due to different assumptions in the models for the various techniques and to the lack of adequate data.

X-ray photoelectron spectroscopy (XPS) is one of the techniques that have been used to measure silicon dioxide film thicknesses. The measured thicknesses depend on knowledge of the effective attenuation length (EAL) of the detected photoelectrons in SiO_2 for the particular film thickness and measurement configuration. Unfortunately, experimental measurements of the EAL typically have varied by up to 50 % and it has been necessary instead to use the electron inelastic mean free path (IMFP). The EAL differs from the IMFP due to the effects of elastic-electron scattering on photoelectron trajectories. The extent of this difference, a systematic uncertainty in the measurement of SiO_2 film thicknesses by XPS, has not been previously investigated.

NIST has collaborated with the Institute of Physical Chemistry in Warsaw, Poland, in a calculation of EAL values for SiO_2 films of varying thicknesses and for typical XPS measurement configurations. For common measurement conditions, the ratio of the EAL to the IMFP is approximately constant (within 3 %) for photoelectron emission angles up to 60°. The average value of this ratio is between 0.906 and 0.935 depending on the x-ray source, the film-thickness range, and the particular XPS configuration. The difference between the value of this ratio and unity, here about 8 %, is a measure of the systematic uncertainty in the XPS thickness measurement. For larger emission angles (often used to increase surface sensitivity), the EAL/IMFP ratio can appreciably exceed unity. These results can be used to make corrections for the systematic uncertainty due to elastic-electron scattering that are appropriate for the specific conditions. Similar calculations can be made for other thin-film materials where the systematic uncertainty in the XPS thickness measurement can be as much as 40 % for common conditions.

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INTERACTIVE WEBSITE FOR ANALYZING MITOCHONDRIAL DNA

A new interactive web site called MitoAnalyzer has been developed by NIST researchers that allows users to determine the effects of single nucleotide polymorphisms, mutations, insertions, or deletions in human mitochondrial DNA. The user enters the nucleotide number and the new nucleotide (A,G,C,T) that has been found, and the program provides information on the effect of changing that nucleotide including if the change has occurred in one of the 22 tRNAs, 2 rRNAs,

or one of the 13 proteins coded by human mitochondrial DNA. If in a protein, the program will provide information on whether an amino acid has been changed and what the new amino acid is. The program also will calculate the position of the new amino acid in the protein (e.g., # 456 in a protein containing 904 amino acids). It will print out the new amino acid sequence and compare it to the original Cambridge Reference sequence. If the change has been associated with a mitochondrial disease, information on the disease is also provided. The web site is at http://www.cstl.nist.gov/biotech/strbase/mitoanalyzer.html. This web site has been accessed over 568 times since it opened on March 16, 2001.

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NON-DESTRUCTIVE MEASUREMENT OF MAGNETOSTRICTION IN THIN FILMS

Thin films of magnetic materials deposited on various substrates are of fundamental importance to the magnetic recording industry as well to the operation of microscale actuators. Their magnetostrictive properties must be tailored to the application and are usually measured by depositing the film on one side of a slender, non- magnetic reed. When an external magnetic field is applied, the bending of the reed yields values for the magnetic field dependence of the magnetostriction coefficient of the film. Drawbacks of this common procedure are that (1) it is destructive in that the reed must be fabricated with specific dimensions, (2) the results are characteristic of the entire film, and (3) the material of the substrate may not be the same as that used in the final application. NIST is developing an ultrasonic technique that can be applied to a local region of the film on any substrate for application to Combinatorial Libraries of magnetostrictive films. This method employs an ultrasonic wave in the substrate to apply an elastic strain of known wave length and frequency to the film. Since the film is magnetostrictive, it generated a magnetic field above the surface that can be detected by a non-contacting coil held above the film. The magnitude of this field and hence the amplitude of the electrical signal from the coil measures the magnetostrictive coefficient of the film under the coil. An external source of a DC biasing magnetic field allows the magnetic field dependence of the magnetostrictive coefficient to be measured. At present, the ultrasonic wave is introduced by a piezoelectric transducer attached to an edge of the substrate some distance from the sensor coil. In the future, this transducer will be replaced by a coil that uses the film's magnetostriction to generate the ultrasonic wave. Thus, a probe that can be scanned over the surface of a magnetic film on any substrate can be constructed and used to measure local magnetostrictive properties of films on devices.

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SMALL-ANGLE NEUTRON SCATTERING UNIQUELY PROBES GENE REGULATORY PROTEIN/DNA COMPLEXES

Scientists at the NIST Center for Neutron Research (NCNR) are using small-angle neutron scattering to obtain unique information about the structure of gene regulatory protein/DNA complexes in solution. Gene regulatory proteins control gene expression in developmental and cellular processes of many organisms. Some are activators, turning genes on and some are repressors, turning genes off. All gene regulatory proteins recognize and bind specific DNA sequences. The binding of gene regulatory proteins to DNA often results in a deformation of the DNA. There also has been recent indirect evidence that the proteins undergo a structural change as well upon DNA binding. Small-angle neutron scattering (SANS) is currently being used at the NCNR to study the structural changes in both the DNA and protein components of DNA/gene regulatory protein complexes. The goal is to better understand the interactions between DNA and proteins in these important biological systems.

SANS is ideal for studying protein/DNA complexes since the neutron scattering strengths of DNA and protein differ with respect to each other. By measuring the complex in solutions containing different amounts of D_2O, with respect to H_2O, different structural components can be highlighted, while others are suppressed. By measuring the protein/DNA complex under a sufficient number of solvent conditions, the structure of the two components can be separately determined, even though both components are bound together as one complex! Thus, SANS allows a unique determination of the structure of the individual components in the complex.

Recent SANS experiments have confirmed that the gene activator protein, cyclic AMP receptor protein (CRP), undergoes a significant structural, or conformational, change in solution upon DNA binding. Furthermore, the regions of the protein that undergo the conformational change contain the binding site for RNA polymerase, which plays a crucial role in the early stages of protein synthesis. This structural change may be necessary in order for CRP to interact with RNA polymerase during this process. Further SANS studies are under way on other protein/DNA complexes that play a role in gene regulation.

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ANALYSIS OF DENTAL COMPOSITES BY NEAR INFRARED SPECTROSCOPY

Collaborative research among the American Dental Association, the University of Colorado, and NIST led to an improved method to analyze dental composites. Vinyl resin based composites are increasingly being used as alternatives to amalgam fillings. The durability and biocompatibility of dental restoratives materials, however, may be affected by the thoroughness to which they polymerize and how much water they will absorb in the oral environment. The collaborative work exploited near infrared (NIR) spectroscopy, which uses clinically relevant sized specimens, to provide information on both vinyl group conversion and water uptake on the same composite specimen. Owing to the non-destructive nature of this analytical technique, these properties can be monitored versus time and aqueous exposure. With NIR spectroscopy, it now becomes possible to assess the influence of the type and amount of filler phase of the composite on conversion and water absorption. In contrast to conventional gravimetric water absorption studies, NIR spectroscopy allows differentiation between free or unbound water and hydrogen-bonded water, thereby aiding in elucidating how water interacted with the polymer network. Recent studies have extended the use of NIR spectroscopy to monitor the conversion of the oxirane group in new types composites utilizing epoxy resin binders.

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NIST PUBLISHES OPEN SOURCE SOFTWARE TOOLKIT FOR XML APPLICATION INTEGRATION

The XSLToolbox, a freely available open source toolkit, helps developers avoid the drudgery of writing complicated transformations often needed to integrate XML (Extensible Markup Language) applications. The XSLToolbox includes a tool for transforming XML documents as specified by ISO/IEC 10744:1997 architectural forms as well as a tool for adding default attribute values to XML data.

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COOPERATIVE RESEARCH DETERMINES POWER QUALITY EFFECTS ON MACHINE TOOLS

NIST scientists have been working with the Electric Power Research Institute (EPRI) to investigate the need for power quality ride-through standards on machine tools. Such standards define the level of power quality events a piece of equipment must be able to tolerate (ride-through) before it automatically shuts down. EPRI standards have been developed and adopted in a number of areas, particularly within the semiconductor equipment industry. Last summer, EPRI engineers and NIST staff measured the performance of a machine tool and several machine tool performance measurement devices (e.g., lasers and encoders) in the NIST Sound Building during synthesized power quality events. This research resulted in close collaboration between NIST and EPRI for conference presentations, participation in power quality workshops, and standards development for the performance assessment of machine tools. The resulting power quality analysis technique and solutions are being considered for a number of machine tools across the United States, with the potential for great cost savings in time and materials.

Since purchasing a particular machining center, NIST has experienced unacceptable machine behavior during local power events that have damaged in-process parts. Malfunctions occur when typical local power events unexpectedly shut down the machine's controller, resulting in the machine spindle falling into the part due to gravity. So far, two frames and one base for the joint U.S. Charters of Freedom Project with the National Archives and Records Administration have been damaged with much loss of time and materials. This machine behavior is not reproducible using the emergency stop function, during a controlled shut-down, or when halting the power using the main breaker. In correspondence with the machine tool manufacturer and controller provider, the local machine distributor was not able to resolve this problem. An option to install special power monitoring and supply to eliminate power fluctuations was not affordable.

In response to this need, the NIST-EPRI collaboration conducted extensive testing of the machining center. The machine performance was measured while subjecting it to varying levels of voltage sag across electrical phases for varying durations. At 60 % of line voltage (a 40 % drop in line voltage on two phases, A and B) and for as little as 5 cycles in duration, the machine controller shuts down in an error mode and the spindle consistently drops up to 18 mm due to gravity. Voltage sags of this level are common in raw, utility-supplied power. The testing also established that the machine electrical systems, with the exception of the controller power supply, stay functional until the 50 % threshold is exceeded.

The testing was able to replicate the machine behavior such that the problem could be quantified. By wiring a constant voltage transformer (CVT) in series with the controller power supply, the problems of machine

malfunctions and damaged in-process parts were overcome. This solution allows the controller to sense an under-voltage condition and shut down the equipment in a controlled fashion. The CVT has been installed permanently on the machine in question, and NIST staff will be monitoring the resulting installation for long-term performance under actual conditions. Further collaboration between NIST and EPRI will add to the existing knowledge through evaluation of additional machine tools and power quality effects.
CONTACT: Brad Damazo, (301) 975-6611; bradley.damazo@nist.gov.

NEW WEB RESOURCES FOR DIMENSIONAL METROLOGY

NIST has launched two new web pages (http://patapsco.nist.gov/mel/div821/) that perform calculations commonly required by engineers and metrologists who are involved in ultrahigh accuracy length measurement. One web page calculates the index of refraction of air, which is needed to determine the wavelength of laser light in air. (This wavelength serves as the basic unit of length when performing high-precision distance measurements based on interferometry.) The second web page calculates the magnitude of elastic deformation of surfaces in contact under force. This deformation must be taken into account in all high-accuracy length measurements when surfaces are probed mechanically.

The refractive index of air is computed from atmospheric conditions (air temperature, pressure, and humidity) using either the Edlén or Ciddor equations (the two equations most commonly used to determine air refractive index). The usual version of the Edlén equation was modified to make it more accurate for non-laboratory conditions, such as high air temperature and humidity as might be encountered on the shop floor.

The deformation calculation web page will allow a user to correct for elastic deformation at the point of contact between a mechanical probe and part. This correction is essential when submicrometer accuracy is desired. Currently the web page performs the computation for the seven most common types of contact geometry (for example, a sphere in contact with a plane or two crossed cylinders). Additional geometric cases will be added in the future.
CONTACT: Jack Stone, (301) 975-5638; jack.stone@nist.gov or Jay Zimmerman, (301) 975-3480; jay.zimmerman@nist.gov.

NEW FITTING ALGORITHM FOR SHAPE-SENSITIVE LINEWIDTH METROLOGY

Is a scanning electron microscope (SEM) image of a semiconductor line produced by a rectangular line of width w, or by a *non-rectangular* line of different width w'? When the lines are less than 100 nm wide and nanometer-scale accuracies are the goal, distinguishing between the different possibilities is crucial to linewidth metrology. NIST scientists are implementing a scheme to make distinctions that are based upon matching measured images to a library of images corresponding, as determined by Monte Carlo model calculations, for a variety of line shapes and widths.

Matching images to the library will be done in three parts:

- a model function that computes the expected image for a given set of parameters that describe the state of the instrument and the width and shape of the line,
- a residuals function that determines the difference between this model image and the one actually observed, and
- a nonlinear least squares fitting algorithm that adjusts model parameters to determine the best match, as judged by minimizing the sum of squares of residuals. The new system has several improved capabilities compared to the system in place late last year:
- It can fit entire images (not merely single line scans) in a single fitting operation. This allows one to realistically require instrument parameters to be fixed for the whole image, instead of varying from line to line.
- It can fit any number of line features per line scan. This means it can handle the industrially important case of dense lines, instead of only isolated lines.
- Parameters can be “pinned.” A pinned parameter is given a fixed value that is not varied for fitting purposes. This provides a convenient way to use calibration data determined from an independent measurement. For example, if the instrument’s beam diameter, brightness, and contrast are known independently, these can be pinned to their known values, leaving sample geometry as the only thing that can be adjusted to produce a fit.

CONTACT: John Villarrubia, (301) 975-3958; john.villarubia@nist.gov.

DIELECTRIC BEHAVIOR OF MATERIALS FOR WIRELESS COMMUNICATIONS PREDICTED FROM FIRST PRINCIPLES

Dielectric materials for wireless communications applications must have high dielectric constant, low loss, and temperature stability. For high-power base station

resonators, the only ceramic known with the required dielectric properties is $Ba_3ZnTa_2O_9$ (BZT). The drive to find low-cost alternatives to BZT motivates our interest in determining the microscopic origin of useful electronic properties. As part of this effort, NIST researchers have performed first-principles calculations of the dielectric properties of $CaTiO_3$ (CT) and $CaAl_{1/2}Nb_{1/2}O_3$ (CAN). These systems are both components of solid solutions that contain phases with favorable dielectric properties. CT and CAN have similar perovskite-related crystal structures but very different room temperature dielectric constants: $\varepsilon = 170$ for CT; $\varepsilon = 27$ for CAN. With lattice parameters and space groups as the only experimental inputs, the researchers used density-functional theory methods to compute ε for CT and CAN as a function of temperature, and obtained room temperature values of 140 and 25, respectively, in good agreement with experiment. Low-frequency phonons dominate the dielectric properties, and their calculations predict important differences between the properties of the low-frequency phonons in CT and CAN. In CT, frequencies are lower and all cations move in opposition to the oxide ions; in CAN however, frequencies are higher and Al and Nb move with the oxide ions. Their calculations of phonon properties have been verified experimentally by infrared reflectivity measurements. Ultimately, determination of the microscopic origin of dielectric behavior will permit the rational, efficient discovery and development of advanced ceramics needed for next-generation applications.

CONTACT: Eric Cockayne, (301) 975-4347; eric.cockayne@nist.gov.

NEW HIGH-SPEED MEASUREMENT COLLABORATION

NIST is creating a "High-Speed Measurement Laboratory." This laboratory will develop calibratable high-speed electrical and optoelectronic measurements for next-generation optical telecommunications, electrical phase standards for nonlinear and other microwave measurements, and high-speed digital integrated circuits.

The laboratory already boasts one success, the development of an electro-optic sampling system for characterizing the magnitude and phase response of fast photoreceivers to 30 GHz. This is significant not only because this unique measurement system is fully calibratable but because it can be extended to the much higher frequencies critical to the optical telecommunications market. The next target is photoreceiver characterization over a 100 GHz bandwidth, which NIST scientists hope to achieve later this year to aid the development of the new 40 GB/s optical links.

But high-speed photodetector characterization isn't the only objective. A photoreceiver with one or two hundred GHz of calibrated bandwidth has many applications. These very fast photoreceivers can be used as transfer standards to establish absolute electrical phase, a critical quantity required for nonlinear device characterization at microwave frequencies, and to push calibrated temporal measurements to microwave frequencies, creating a new microwave-measurement paradigm.

CONTACT: Thomas R. Scott, (303) 497-3651; scott@boulder.nist.gov or Robert Judish, (303) 497-3380; judish@boulder.nist.gov.

NEW LAW ENFORCEMENT STANDARD FOR INTERCEPTS ON DIGITAL NETWORKS

NIST's Office of Law Enforcement Standards (OLES) has completed work on NIJ Standard 0227.00, Digital Intercept System (DIS) For Integrated Services Digital Networks (ISDN). The digital intercept system provides the capability to intercept any voice or digital data traffic between a subscriber and an associate and forward it to a central collector station for decoding and processing. The central collector allows a monitoring agent to monitor the progress of the call and to record and play back information captured from the subscriber's line.

The standard was developed under the sponsorship of the National Institute of Justice (NIJ). The project started when NIST/OLES entered into an interagency agreement with the Federal Bureau of Investigation to provide technical guidance in developing ISDN intercept methodologies. After the technology was successfully demonstrated, the preparation of the performance standard was undertaken. Since the standard is quite lengthy (over 800 pages), it has been published as a CD-ROM. The CD is available without charge to those individuals or organizations who submit a request to the contact listed below. The standard bears a "For Official Use Only" classification, thus the request must indicate an official need to know this information.

CONTACT: George Lieberman, (301) 975-4258; george.lieberman@nist.gov.

SUPERCONDUCTOR WITH HIGH NIOBIUM ARCHITECTURE HAS UNEXPECTEDLY GOOD ELECTROMECHANICAL PROPERTIES

The fabrication of the next generation of particle accelerators for high energy physics will require the development of new niobium-tin/copper superconductors able to carry extremely high current densities at high magnetic fields. One technique for accomplishing this is to push the density of superconductor in the

composite wire to new limits. Such an experimental, high-niobium composite was fabricated recently by a private company. A concern in the high-energy-physics community was that the conductor would have very low tolerance to mechanical strain. To test the conductor, NIST scientists modified their axial electromechanical test apparatus and used a new 16.5 T, high field magnet. Surprisingly, the conductor had electromechanical tolerance similar to standard Nb_3Sn composites. The irreversible strain, beyond which the conductor shows permanent degradation, had a relatively high value of 0.85 %. The peak critical current was measured at a strain of 0.34 %. This result clears the way for wire manufacturers to push the niobium density to even higher values, which would provide a significant extension of the magnetic field limit of present accelerator magnets.

CONTACT: Jack Ekin, (303) 497-5448; ekin@boulder.nist.gov.

MAGNETIC SUBSTRATES REDUCE PERFORMANCE OF Y-Ba-Cu-O COATED SUPERCONDUCTORS

Measurements by NIST scientists on Y-Ba-Cu-O coated superconductor tapes revealed that the use of magnetic substrates may reduce the current carrying capacity of the tapes when they are arranged in stacks of two or more layers. This finding has a significant bearing on the potential use of coated superconductors with magnetic substrates, particularly in low-field applications such as transmission lines. The disclosure of NIST's findings resulted in an accelerated effort at the Department of Energy's national labs and their industrial partners to develop non-magnetic substrates for coated-conductor fabrication.

High temperature superconducting tapes based upon coatings of Y-Ba-Cu-O on textured, buffered, magnetic nickel substrates showed a 15 % degradation in critical-current density when the Y-Ba-Cu-O layer was sandwiched between two magnetic nickel substrates. This configuration commonly occurs in many applications where the conductor needs to be cabled or wound, such as in transmission lines and magnets. The interaction of the top and bottom nickel layers increases the perpendicular component of magnetic flux at the superconductor tape edges. This reduces the current carrying capacity of the superconductor due to the presence of the magnetic field. Removing the top nickel substrate restores the critical current density to its original value.

CONTACT: Jack Ekin, (303) 497-5448; ekin@boulder.nist.gov.

NIST CO-SPONSORS PERVASIVE COMPUTING 2001 CONFERENCE

In May 2001, NIST, with NSA's Advanced Development Research Activity, cosponsored its second annual pervasive computing conference. As an open forum for the IT industry, the conference offered key perspectives on pervasive computing, including the latest in technologies, real applications, and business views.

Presentations centered about the need to understand the nature of change and opportunity associated with this new computing environment. A noteworthy conference benefit to industry will be reflected in its ongoing collaboration with NIST in such critical areas as multimodal industry standards, interfaces, privacy, and security. Pervasive computing topics discussed included health care industry applications, business-wide applications, intelligent environments, applications in mobile commerce, software and services, networking technology infrastructure, concluding with a technology update on emerging standards for pico-cellular wireless communications and dynamic service discovery.

Pervasive computing refers to the emerging trend toward numerous, easily accessible computing devices connected to an increasingly ubiquitous network infrastructure composed of a wired core and wireless edges. This trend likely will create new opportunities and challenges for the IT marketplace, placing high-performance computers and sensors in virtually every device, appliance and piece of equipment, in buildings, homes, workplaces, and factories, and even in clothing. Pervasive computing will require innovative approaches to human-computer interaction and information access technologies, as there will be a shift toward interacting with small, distributed, and often invisible devices. More information about the conference is available at www.nist.gov/pc2001.

CONTACT: Bill Young, (301) 975-8701; william.young@nist.gov.

NIST AND PARTNERS HELP BLAZE THE PATH TO METATOPIA

Having an enormous amount of information at your disposal to help you make decisions is a wonderful experience. Yet, people often complain of the overload problem that comes from having too much data.

Some researchers believe a partial solution may be found in metadata—essentially data about data that describe how, when and by whom a particular set of data was collected, and how the data are formatted. If it works well, say IT experts, you have a state of information heaven, or "metatopia." To help data managers

reach this "IT Nirvana," NIST is sponsoring Metatopia 2001, a symposium on metadata and data management, on Sept. 20-21, 2001, at NIST headquarters in Gaithersburg, MD.

The conference is of interest to executives in fields such as data mining, knowledge management, and data warehousing. The primary focus is on metadata and how it can be standardized.

The Data Management Association-National Capital Region is co-sponsoring the conference along with the ANSI NCITS Metadata Committee (L8).

More information about the Metatopia 2001 symposium is available at www.dama-ncr.org/Metatopia2001. Media Contact: Philip Bulman, (301) 975-5661; philip.bulman@nist.gov.

NEW ONLINE NEWSLETTER LINKS RESEARCHERS AND FIREFIGHTERS

Millions of dollars are spent annually in fire prevention research to lessen a toll which, in the United States, amounts yearly to more than 5000 deaths, 25 000 injuries and $9 billion in direct property loss. To inform the firefighting community of this work, NIST and the United States Fire Administration have launched an online newsletter, FIRE.GOV, at www.fire.gov.

The free quarterly publication, started in response to a call by the International Association of Fire Chiefs (an organization representing more than 12 000 chief fire and emergency officers), provides information about research activities that could impact firefighting safety and effectiveness. Contact information is provided so that firefighters can interact directly with the researchers.

The first issue includes reports on techniques for measuring the performance of protective clothing, the fire suppression effectiveness of compressed air foam, the search for an environmentally friendly suppressant for liquid fuel fires, as well as an account of scientific forums on urban/wildland firefighting technology. Future issues will consider other non-commercial fire research activities performed by government, universities, industry and fire departments.

The newsletter can be viewed in HTML or downloaded in a PDF version. Subscriptions to FIRE.GOV, providing delivery of new issues via e-mail, are available online. For more information, contact FIRE.GOV editor Dave Evans, (301) 975-6897; dave.evans@nist.gov.
Media Contact: John Blair, (301) 975-4261; john.blair@nist.gov.

NIST LAUNCHES SERIES OF GUIDES TO EU DIRECTIVES

Three newly issued NIST guides to European Union directives on machinery, low-voltage equipment and electromagnetic compatibility can help U.S. manufacturers carry out the steps necessary to demonstrate compliance with the EU-wide requirements and gain unfettered access to the 18-nation market.

The easy-to-use introductory references are designed to acquaint businesses and government officials with the directives' essential requirements and their relationship to other EU product safety laws. Each one lists the types of products covered by the particular directive (as well as those that are excluded) and addresses issues regarding the treatment of components incorporated into market-ready products. In addition, the guides explain the hierarchy of EU, international and national standards that might be used to satisfy the directives. Each contains the text of the relevant directive and a list of applicable EU harmonized standards.

Intended to foster the free movement of goods among nations that make up the European Economic Area, the laws are among the more than 20 "new approach" directives approved by the EU's governing body since 1992. Products that comply with relevant directives merit the required "CE mark"—kin to a passport for products marketed in Europe.

The directive on low-voltage equipment, such as appliances and power tools, is designed to prevent electrical hazards to people, pets, livestock and property, while the machinery directive aims to ensure the safety of industrial equipment. The electromagnetic compatibility directive applies to a wide range of products and is intended to prevent electrical and magnetic disturbances that can undermine the performance of other products and systems.

The new publications are available at NIST's conformity assessment web site at http://ts.nist.gov/ca. They are the first in a series of NIST-commissioned guides on selected EU new approach directives. The series is being developed with the Commerce Department's International Trade Administration.

A limited number of NIST's guides to the EU directives will be available. Specify the directive of interest and send a self-addressed mailing label to Maureen Breitenberg, NIST, 100 Bureau Dr., Stop 2100, Gaithersburg, MD 20899-2100.
Media Contact: Mark Bello, (301) 975-3776; mark.bello@nist.gov.

NOVEMBER CONFERENCE TACKLES TEXT RETRIEVAL SYSTEMS

Everyone knows that "looking for a needle in a haystack" is tough work. However, when the needles are single bits of information and the haystack is the enormous collection of data available via the Internet, one needs help to do the search.

That's where text retrieval systems-the tools used to track down and isolate those needles-come in. Developing more powerful, faster and easier-to-use text retrieval systems to meet the demands of the Information Age requires a coordinated research effort. Therefore, NIST and the Defense Department have held the Text Retrieval Conference (known as TREC) since 1992 to provide the infrastructure necessary for large-scale evaluation of text retrieval methodologies. The 10th TREC will be held on Nov. 13-16, 2001, at NIST headquarters in Gaithersburg, MD.

TREC is overseen by a program committee consisting of representatives from government, industry and academia. For each TREC, NIST provides a test set of documents and questions. Participants run their own retrieval systems on the data and return to NIST a list of the retrieved top-ranked documents. NIST pools the individual results, judges the retrieved documents for correctness, and evaluates the results. The TREC cycle ends with a workshop that is a forum for participants to share their experiences.

This year, TREC is expanding to include, for the first time, a video track, because a growing amount of information is being stored in that form. This is a step toward including a general multimedia track in future years. Other topics will include web search engine systems and cross-language systems.

Attendance is limited to researchers and groups who submit search results to the conference. For more information on TREC, go to http://trec.nist.gov or contact Ellen Voorhees, (301) 975-3761; ellen.voorhees@nist.gov.

Media Contact: Philip Bulman, (301) 975-5661; phillip.bulman@nist.gov.

FALL CONFERENCE TO SHOWCASE NEW CASES FOR CHARTERS OF FREEDOM

Millions of Americans consider three documents—the Constitution, the Bill of Rights, and the Declaration of Independence—tangible, irreplaceable works of political genius and national patriotism. This Constitution Day, Sept. 17, 2001, NIST will host a scientific conference celebrating its current role in preserving these "Charters of Freedom" for future generations. The conference will be held at NIST headquarters in Gaithersburg, MD.

The NIST-built encasement for the Bill of Rights will be formally transferred to the National Archives and Records Administration during the conference's opening ceremony. The handover completes a two-year project to make nine state-of-the-art encasements that will secure the Charters against all types of environmental assault including light, oxygen and humidity. Five of the gold-plated titanium frames will hold the four pages of the Constitution and its transmittal page, which was signed by George Washington. One encasement will hold the Declaration of Independence and another, the Bill of Rights. Two prototype frames, built at the start of the project, will be used as spares.

The Charters will be moved to their new "homes" while away from public display between July 5, 2001, and sometime in 2003.

Conference speakers will describe the current Charters encasements—built by NIST in the 1950s—and present data on their performance. They will then discuss the design, manufacture and initial performance of the new NIST cases that embody the best manufacturing and preservation technology have to offer. Cutaway models of the two case sizes manufactured will be on display.

Detailed design and production information on the new Charters encasements, historical background on the documents and their 1950s preservation, visuals and more are available at www.nist.gov/charters. Also available is a link to the web site for the Sept. 17 conference, "A History of Encasements: Technology Preserving the Charters of Freedom."

Media Contact: John Blair, (301) 975-4261; john.blair@nist.gov.

NIST FORMS TEAM TO TACKLE INSPECTION SOFTWARE PROBLEMS

Automating the process of product inspection during manufacturing should cut product development cycle time and manufacturing costs. However, the wide variety of inspection software and hardware products on the market may make it difficult to achieve full benefit from an automated process. Common interfaces may be non-existent, measurement programs may require retooling to make them compatible with new or added software packages, and training for multiple operator interfaces adds to production costs and delays inspections.

Last month, NIST joined manufacturers and information technology vendors in an effort to overcome software interface barriers for automated dimensional measurement. The new group, known as the Metrology Interoperability Consortium, will be developing and testing interoperability standards for the hardware and software components used.

The consortium's 3 year action plan includes: cataloguing gaps in current standards; evaluating current and developing standards for particular interfaces to determine which ones deserve support; identifying and assisting in harmonization of competing or overlapping standards; developing specifications for interfaces where no satisfactory non-proprietary standard exists; and assembling consensus user requirements to provide as input to standards developing organizations.

Finally, consortium members will develop and perform conformance and interoperability tests for software that incorporates the standards. Projects that require testing will be carried out using a National Metrology Testbed that consists of equipment and software owned and operated by the participants at their own sites. NIST will develop procedures and tools for conformance and interoperability testing.

Membership in the Metrology Interoperability Consortium is open to users, vendors and third party organizations. For more information, contact Al Wavering, (301) 975-3461; albert.wavering@nist.gov.
Media Contact: John Blair, (301) 975-4261; john.blair @nist.gov.

WORK WELL UNDER WAY ON WORLD'S PREMIER MEASUREMENT LAB

A drive past NIST headquarters in Gaithersburg, MD, these days might have you looking twice. There's an ever-growing stockpile of dirt on the campus' southern side from excavations, five (and soon to be six) cranes poised high above a construction site and the sight of people and machines busily at work on a very special building.

When it is ready for occupancy in 2004, the 47 480 m^2 (511 070 ft^2), $235.2 million Advanced Measurement Laboratory will give NIST and its partners in U.S. industry and science access to research and development capabilities not available anywhere else in the world. The laboratory will have state-of-the-art controls for humidity, temperature, vibration, and air quality. Two of the AML's five wings will be built underground with special active and passive vibration isolation systems. The unique characteristics will help its occupants achieve higher quality reference materials, improved measurements and standards, and more rapidly developed research advances.

Instrument East, currently scheduled to wrap up in mid-2003, will be the first portion of the AML finished. Other target completion dates are mid-to-late 2003 for the cleanroom and the Metrology East wing, and late 2003 for the Instrument West and Metrology West wings.

For more information on the AML, along with an artist's rendition of the finished facility and a live webcam view of the construction site, go to http:// aml.nist.gov.
Media Contact: Michael E. Newman, (301) 975-3025; michael.newman@nist.gov.

RADIOMETRIC CHARACTERIZATION PERFORMED AT NIST IMPROVES ACCURACY OF THE MARINE OPTICAL SPECTROGRAPH

The Marine Optical Buoy (MOBY) project is a part NASA's Earth Observing System Program, and supports the validation of satellite ocean color imagery data that are used for understanding the global carbon cycle. The Marine Optical Spectrographic (MOS) system is used in MOBY to derive water-leaving radiance.

For the first time, a rigorous study of the radiometric properties of the MOS was performed using NIST's Spectral Irradiance and Radiance Calibrations with Uniform Sources (SIRCUS) facility, which uses broadly tunable lasers and integrating spheres to calibrate and characterize a wide variety of detector-based instrumentation. Using the measurements from SIRCUS, physicists at NIST assessed the effect of stray light on MOS measurements of water-leaving radiance. A stray-light-correction algorithm was developed and applied to a subset of MOS data sets, greatly reducing the uncertainty in these measurements. This work will have immediate impact on the ocean-color remote-sensing community.
CONTACTS: Carol Johnson, (301) 975-2322; cjohnson@nist.gov or Steve Brown, (301) 975-5167; steven.brown@nist.gov.

NIST AND NFPA PROFILE SMOKE TOXICITY HAZARD

Smoke toxicity has been a recurring theme for fire safety professionals for over four decades. There continues to be difficulty and controversy in assessing and addressing the contribution of the sublethal effects of smoke in hazard and risk analyses. NIST and the National Fire Protection Association have completed the first phase of the "International Study of the Sublethal Effects of Fire Smoke on Survival and Health" to provide scientific information on this topic for public policy makers and product manufacturers. This report estimates the magnitude and impact of sublethal exposures to smoke on the U.S. population, provides the best available, previously published lethal and incapacitating toxic potency values for smoke from

commercial products, determines the potential for various size fires to produce smoke yields that could result in sublethal exposures, and provides state-of-the-art information on the production of condensed components of smoke and their evolutionary changes during transport from fire.
CONTACT: Dick Gann, (301) 975-6866; richard.gann@nist.gov.

NIST TEAM DEVELOPS SCREENING TOOL FOR NEW FIRE SUPPRESSANTS

The Next Generation Fire Suppression Technology Program, led by a NIST scientist, is the Department of Defense's research effort to identify alternatives to the commonly used fire suppressant halon 1301 (CF_3Br), now known to deplete stratospheric ozone. A key portion of this program is the development of tools to evaluate the fire suppression performance of new candidate extinguishants for use in suppressing in-flight aircraft fires. A NIST team has completed work on the Transient Application, Recirculating Pool Fire (TARPF) Facility. This device measures the suppression effectiveness of impulsively discharged gases (such as from a pressurized storage bottle or solid propellant gas generator), the impact of a hot surface on continuous suppression, the impact of a recirculating flow; and the impact of a liquid spray. The flow patterns in the device have been modeled to extend the applicability of the experimental results to a variety of conditions prevalent during aircraft fires.
CONTACT: William Grosshandler, (301) 975-2310; william.grosshandler@nist.gov.

WORK BY NIST RESEARCHER SUGGESTS PERFORMANCE BREAKTHROUGH IN SPEAKER RECOGNITION

A possible performance breakthrough by a NIST scientist involving significant reduction in error rates was reported at the 2001 Speaker Recognition Workshop, held in May 2001, in Linthicum, MD. Hosted by NIST, the workshop reviewed the recently concluded 2001 Speaker Recognition Evaluation. Twelve academic and industrial research organizations participated: six from the United States, three from France, and one each from Spain, India, and Australia.

The evaluation covered several basic tasks involved in text-independent speaker recognition and included eight different tests. Sites achieving the best scores on the tests were noted, although differences between competing systems were sometimes small. NIST researchers gave three presentations at the workshop, analyzing performance results for different parts of the evaluation. Most of the data used in the evaluation were excerpts from the Switchboard Corpora of conversational telephone speech, generated at NIST. A new Switchboard Cellular Corpus was used at the workshop, marking the first time that cellular telephone data has been used in a speaker recognition evaluation. Such cellular data will serve as primary data in the next evaluation.

In a possible performance breakthrough based on results of preliminary work, a NIST researcher showed that much useful information for characterizing speakers could be found in longer-term speech characteristics, particularly the frequent usage of certain words or phrases. He showed that such "idiolectal" features of speech, obtainable from word transcripts, even errorful transcripts produced by automatic speech recognizers, could greatly enhance performance. For this task, he used test segments consisting of entire conversation sides (taken from conversations of 5 to 10 minutes each) and training data for each speaker consisting of several, preferably at least eight, such conversation sides.

To further explore the use of idiolectal characteristics of speakers in speaker recognition, a new extended data one-speaker detection task was included in this year's evaluation. For this evaluation, systems were provided with much larger amounts of training and test data and with word transcripts generated by an automatic speech recognizer. Speaker detection performance was evaluated by measuring the correctness of detection decisions by the systems. These decision scores were used to produce error trade-off curves in order to see how misses may be traded off against false alarms. Two sites, MIT-Lincoln Laboratory and R523 (DoD), produced systems for this evaluation. Their performance results were quite impressive, reducing previously seen error rates on such data by up to an order of magnitude.

This work is an exciting development that could have significant applications and that brings together emerging speech recognition and speaker recognition technologies. More information about the speaker recognition program is available on the web at http://www.nist.gov/speech/tests/spk/index.htm.
CONTACT: Alvin Martin, (301) 975-3169; alvin.martin@nist.gov.

NIST PUBLISHES SPECIAL PUBLICATION 250-58: *CALIBRATION OF X-RAY AND GAMMA-RAY MEASURING INSTRUMENTS*

NIST has recently revised and published a key Measurement Services Guide, NIST Special Publication 250-58, which describes completely the x-ray and gamma-ray calibration services provided at NIST. This publication replaces the 1988 NBS Special Publication 250-16 that has been widely distributed for the past decade to those interested in x-ray and gamma-ray measurements for medical applications. This revised edition now includes details of the NIST mammography calibration facility, results of recent international x-ray comparisons, new reference beam quality parameters, and documentation of current uncertainties associated with the calibration service.

The calibration and irradiation of instruments that measure x rays and gamma rays are performed in terms of the physical quantity: air-kerma. The measurement of air-kerma and the calibration process involves a comparison of the test instrument to a NIST primary standard, which includes four free-air ionization chambers for x rays and cavity ionization chambers for gamma rays. The document will be useful to those who use the NIST radiation calibration service and for others who are currently developing services similar to those provided at NIST. SP 250-58 will soon be available on the web.

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SPONTANEOUS COHERENT MICROWAVE EMISSION AT SURF III

Following the long established theory of synchrotron radiation emission, all synchrotron radiation is emitted in harmonics of the frequency of the accelerating radio-frequency field. Researchers at NIST have made this "picket-fence" structure visible at the Synchrotron Ultraviolet Radiation Facility, SURF III, for microwave radiation emitted at frequencies around 10 GHz, which corresponds to the 100th harmonic. This microwave radiation was easily detectable, because of its coherent enhancement by a "sawtooth" or longitudinal bunch instability in the electron beam. A collaborative study of this phenomenon with researchers at the Argonne National Laboratory's Advanced Photon Source is reported in the May 2001 issue of the journal *Physical Review Special Topics—Accelerators and Beams.*

The major breakthrough in this study was the identification of the connection between spontaneous coherent synchrotron radiation emission, micro-bunching, intensity noise in the visible spectral range, and the sawtooth instability, which has long been known to affect SURF under certain operating conditions. This greater understanding of SURF III beam dynamics has contributed significant improvements in beam stability that have been obtained recently.

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SINGLE-CRYSTAL CRITICAL DIMENSION REFERENCE MATERIALS DELIVERED BY NIST RESEARCHERS TO INTERNATIONAL SEMATECH

NIST researchers have delivered prototype critical dimension reference materials for calibrating linewidth metrology instruments used in manufacturing semiconductor devices to International SEMATECH (ISMT) for evaluation by member companies. The work was the result of collaborations with ISMT, a private company, Sandia National Laboratories, and NIST to fabricate, test, and evaluate this new class of reference artifacts to meet the goals of the Semiconductor Industry Association's International Technology Roadmap for Semiconductors (ITRS). ITRS states that it is critically important to have suitable reference materials for lithography support available for development of advanced materials and process tools as well as on-wafer measurements for integrated circuit (IC) manufacturing. The ITRS projects the decrease of gate linewidths used in state-of-the-art IC manufacturing from present levels of approximately 250 nm to below 70 nm within several years. Until now, such reference materials have been unavailable because of the lack of a technology needed for their fabrication and certification.

In order to be compatible with users' metrology instruments, test chips containing the reference features were mounted in a "reference-material carrier" wafer also developed by NIST staff. This carrier consists of a blank 200 mm silicon wafer with a recessed "pocket" etched in the center with dimensions appropriate to accommodate the chip. Fifteen carrier wafers, each containing a chip with a reference feature having a critical dimension in a range from 80 nm to 140 nm, were delivered to ISMT for evaluation by its member companies.

The technical approach was to design the reference features into electrical test structures, thus enabling the determination of their electrical linewidth. A selection of 36 test structures was incorporated into the test chip that was patterned in the device layer of 110 silicon-on-insulator wafers based on well-established silicon micro-machining technology that produced feature sidewalls having near-atomic planarity. Primary calibration of the critical dimension of the test-structures on all the

test chips was accomplished by means of high cost, low speed High Resolution Transmission Electron Microscopy (HRTEM) imaging and lattice-plane counting at a limited number of sites on the wafer. HRTEM provides nanometer-level accuracy, but is sample-destructive and is prohibitively costly to implement on all reference features. The samples delivered to ISMT were calibrated via a statistical correlation with their high-precision electrical critical dimension measurement.

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NIST DEMONSTRATES REMOTE OPERATION OF 10 V JOSEPHSON VOLTAGE STANDARD SYSTEM

A NIST scientist recently demonstrated the new Windows version of the control software for the 10 V Josephson Voltage Standard (JVS) system. This software is the first to provide remote operating capability of JVS systems. A laptop computer with a modem connection in a conference room in Gaithersburg was used to dial-up the 10 V JVS in the Josephson Array Technology Lab in Boulder. Complete remote control of the system was demonstrated by performing a number of calibrations. The new software will replace older DOS-based software, making the system compatible with current computer hardware and software. Remote operation will reduce operating costs of JVS systems by allowing an operator or repair expert to monitor, control, and diagnose JVS systems from any location. Future enhancements will allows JVS operators to collect statistics and perform all the capabilities of the earlier DOS-based software.

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CONSTANT VOLTAGE STEPS IN JOSEPHSON JUNCTION SERIES ARRAYS AT 10 K

NIST is collaborating with Japan's Electrotechnical Institute, which has recently become part of the National Institute of Advanced Industrial Science and Technology (AIST), to develop a higher temperature programmable voltage standard, so that this system can operate with a practical cryocooler. NIST has provided fabrication development advice and circuit designs and circuit testing. After considerable improvements in their fabrication process over the last two years, including the addition of two planarization steps and the addition of NbN wiring, the Japanese group has made the first all-NbN arrays with useful operating margins. Arrays of 4096 junctions have sufficient uniformity at a 10 K operating temperature to generate constant voltage steps.

NIST hopes to continue this collaboration with AIST and begin stacking the junctions for lumped arrays. The uniformity is also good enough to begin designing circuits with 33 000 (unstacked) junctions for 10 K programmable voltage standard circuits.

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SEVEN-TIMES RESOLUTION IMPROVEMENT IN NARROWBAND POLARIZATION-MODE DISPERSION

Measurements Polarization-mode dispersion (PMD) is the parameter currently limiting higher data rates in optical fiber communications. Therefore, it is critical to have PMD metrology able to characterize these systems. In order to achieve high data rates, wavelength channel spacings are steadily decreasing from 200 GHz to 25 GHz and narrower. Fundamental tradeoffs exist in the measurement of PMD that bring higher measurement uncertainty as the measurement bandwidth is reduced. In 1998, in an effort to address narrow-band PMD measurement needs, NIST demonstrated a Modulation-Phase Shift (MPS) technique able to measure PMD in a narrow 4 GHz bandwidth. That system had a PMD resolution of 150 fs. While the technique was a useful improvement, the PMD resolution was poor compared to resolutions of a few femtoseconds achievable by wider-bandwidth PMD techniques such as Jones Matrix Eigenanalysis.

Now, NIST has assembled a second-generation MPS system that has demonstrated a PMD resolution of about 20 fs in a bandwidth of 5 GHz, an approximate seven-fold improvement over the previous MPS system. We are not aware of any other MPS system with such high PMD resolution. The system is based an RF comb-generator that modulates laser light at 2.46 GHz and mixes the detected power to a 123 MHz frequency measurable by a low-phase-noise RF lock-in amplifier. The PMD resolution of the system appears to be limited by the phase noise of the lock-in amplifier itself. We have also found the technique to be surprisingly susceptible to optical reflections in the component under test. Future work will be done toward reducing optical reflections and their effects.

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UNIFORM Ti-BARRIER JOSEPHSON JUNCTION ARRAYS FOR AC JOSEPHSON VOLTAGE STANDARD

NIST researchers have made the first uniform arrays of Josephson junctions using titanium as a junction barrier material. We have focused on using Ti because it can be reactive ion etched with the superconducting Nb electrodes. A considerable effort has been made in experimenting with different etch chemistries to improve the etch anisotropy for etching pentalayer Nb-Ti-Nb-Ti-Nb junction stacks. Two vertically stacked junctions fabricated with this process should have nearly identical areas that very closely match the photoresist dimensions.

Using this new process we recently fabricated arrays of single (unstacked) Nb-Ti-Nb junctions in microwave circuits designed for arbitrary waveform synthesis. These junction arrays are embedded in microwave circuits, which are used to evaluate the junction uniformity. We successfully generated constant-voltage steps in 1000- and 4100-junction series arrays. This is a very good result because it shows that the correct voltage is generated over significant current range for a broad range of frequencies for this large 4100-junction array. This indicates good junction uniformity as well as good microwave uniformity for the entire circuit design. Most of the structure in this circuit is caused by filter resonances, which are also under development. Stacked 2-junction pentalayer arrays are under development.

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RESONATING TORQUE MICROBALANCE DEVELOPED FOR *IN SITU* MEASUREMENTS OF FERROMAGNETIC FILMS WITH SUB-MONOLAYER SENSTIVITY

Work at NIST to develop ultra-sensitive magnetometers based on micromechanical sensors has led to a new instrument for *in situ* measurements of ferromagnetic films. In particular, measurements of thin-film properties critical to the development of read head sensors and magnetic recording media are being investigated.

The production and development of many contemporary magnetic devices require that consistent growth conditions be maintained during thin-film deposition processing steps. Typically, film properties are determined *ex situ* with induction-field (*B-H*) loopers that measure the $M_s t_f$ product for the film, where M_s and t_f are the saturation magnetization and the thickness of the film, respectively. The goal of this project is to develop an instrument that depends on inexpensive, batch-fabricated, micromechanical substrates for quantitative measurements with sub-monolayer magnetic moment sensitivity.

NIST scientists are the developers of an instrument that measures the magnetic torque on a film as it is being deposited onto a single-crystal silicon microcantilever. An optical fiber interferometer is used to measure the deflection of the cantilever. Optic-fiber detectors work well in the high noise environment typical of deposition systems. The magnetic torque is applied near the mechanical resonance of the cantilever to take advantage of the quality factor enhancement of the mechanical torque signal. Dynamic feedback is used to balance the magnetic torque by applying a mechanical force at the base of the cantilever that is just equal and opposite to the magnetic torque. The dynamic feedback approach minimizes the mass loading and the effects of temperature-dependent elastic modulus that change the resonant frequency of the cantilever during deposition. The cantilevers were custom designed for this application and fabricated in the new NIST microelectromechanical sensors fabrication facility in Boulder.

The technique provides a way to make quantitative measurements of the saturation magnetization of thin-film samples with very small total magnetic moments. The Brownian motion of the cantilever sensor fundamentally limits its ultimate sensitivity; at room temperature this corresponds to a 0.02 nm thick ferromagnetic film with the current cantilever geometry.

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DIRECTORY OF PRIVATE-SECTOR PRODUCT CERTIFICATION PROGRAM UPDATED

The 2001 edition of the NIST Special Publication 903, Directory of *U.S. Private Sector Product Certification Programs,* is available. NIST is obligated to provide conformity assessment information, including information on private sector certification bodies, under a number of acts and international and regional trade agreements. This directory helps fulfill some of those obligations and also aids in recognizing the diversity, and therefore the complexity, of U.S. private sector product certification activities.

The revised directory summarizes the product certification activities of over 122 non-governmental organizations based in the United States. It includes organizations that operate strictly within the United States, those that operate at both the U.S. and international levels, and those that operate as the U.S. component of an international program. The directory includes only product or facility-related certification programs. It does not attempt to address programs that certify, register, or accredit services, professional skills, or quality/environmental management systems. However, an appendix has

been included in the directory to provide information obtained from the websites of major certifier organizations that did not respond to several requests for information on their programs.

The directory includes organizations which: administer a certification program and certify that products meet some criteria; administer a program using an independent, third party certifier; or serve as the independent, third parties certifier for a program administered by another organization. Entries in the directory describe the type and purpose of each organization, the nature of the activity, products certified, standards used in the assessment, certification requirements, and any accreditation or recognition by a U.S. or foreign private sector or government agency, availability of services, methods of cost determination, and other relevant details. Where available, a representation of the organization's mark is included with each entry, as well as a pictorial index of all such marks.

Special Publication 903 is designed to meet the needs of federal agencies and standards writers, as well as manufacturers, engineers, purchasing agents, distributors, and others concerned with product-related certification procedures.

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NOVEL COMBINATORIAL METHODS FOR INORGANIC THIN FILMS

Over the past decade, combinatorial chemistry, which involves high throughput synthesis and analysis of a multivariable "library" containing a large number of miniaturized samples, has revolutionized the drug discovery process in the pharmaceuticals industry. Recently, materials scientists have been applying combinatorial principles to the discovery and optimization of inorganic thin films for electronic, photonic, and magnetic devices; this requires unique tools for library fabrication and characterization. Researchers at NIST have developed a novel dual-beam, dual-target pulsed laser deposition process for the fabrication of compositionally-graded thin film libraries. The deposition system has high-speed, *in situ* diagnostics, which permit real-time fine-tuning of the two laser plumes to optimize the deposition parameters. This technique is applicable to a wide range of complex oxides, metals, and metal/oxide composites. To date, libraries of $BaTiO_3$-$SrTiO_3$, a material of interest for wireless communication devices, have been deposited on silicon substrates. Film thickness has been mapped at a spatial resolution of 0.3 mm using a spectroscopic reflectometry apparatus designed by NIST researchers. Composition and dielectric properties of the libraries are being characterized by high throughput measurement techniques.

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ELASTIC CHARACTERIZATION OF ANISOTROPIC THIN FILMS USING SAW DISPERSION

NIST is developing theoretical and experimental techniques for non-destructive measurement of elastic characteristics of anisotropic thin films. Presently there is a strong industrial interest in elastic characterization of thin films because they have applications in electronic, photonic, and magnetic devices and are also used as wear and corrosion resistant coatings on ordinary materials. Material parameters of interest for elastic characterization of a film are the elastic constants of the film, its density, and thickness. In general, the films as well as the substrate in modern materials are elastically anisotropic. Current theoretical and experimental methods of non-destructive characterization are not convenient for anisotropic layered solids.

Experimentally, NIST measures the phase velocity of a surface acoustic wave (SAW) over a broad frequency range. NIST created a laser-ultrasonic apparatus for broadband SAWs. The system incorporates a 0.2 ns pulsed laser for SAW generation and a Michelson interferometer detector with bandwidth over 800 MHz. NIST used this apparatus to measure dispersion relations in several samples including titanium nitride films on single-crystal silicon and stainless steel samples. The thickness of these films ranged from about 250 nm to 3500 nm.

For the purpose of analysis of the dispersion data for SAWs, NIST developed a computationally efficient representation of the Green's function to model the elastodynamic characteristics of an anisotropic thin film on an anisotropic substrate. In this model, the Green's function is represented in terms of a delta function of space and time in slowness space. For anisotropic solids, this representation is computationally more convenient than the convention Fourier reciprocal space and frequency representation. Our model can account for surface texture of the film and imperfect interfacial bonding between the film and the substrate. The elastodynamic model is used to calculate the dispersion of surface acoustic waves in the film and also provides an efficient algorithm for the inverse problem of characterizing the film from measured values of the dispersion. NIST applied this method to calculate SAW velocities in various isotropic and anisotropic films including textured polycrystalline films of TiN on single-crystal

Si and to estimate the elastic constants of the films. Excellent agreement is obtained between the theoretical and measured values of the SAW velocities in most cases.

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COMBINATORIAL CHARACTERIZATION OF BLOCK COPOLYMER FILM MORPHOLOGY

Combinatorial methods have been successfully applied by researchers at NIST to observe novel morphologies and to establish fundamental kinetic relationships in the ordering properties of block copolymer films. Copolymers are a class of polymer materials that have large potential for commercial applications. Unique properties in melts, blends and solutions lead to their use as adhesives, emulsifying agents, thermoplastic elastomers, compatibilizers, etc. Block copolymers are an important sub-class of copolymers consisting of polymers of different chemistry that are covalently linked.

A key question in block copolymers is the nature of interactions between blocks, as well as block interactions with different materials. To address this question NIST researchers exploited the ability of block copolymers to form quantized periodic structures, such as lamellae, that directly reflect molecular parameters such as block lengths, chemical interactions between the block constituents, and interactions with an external (substrate) material in thin films. The work of the NIST researchers published in *Physical Review Letters* and *Journal of Polymers Science Polymer: Part B Polymer Physics*, demonstrates that these fundamental properties can be very efficiently determined in a high-throughput manner using a combinatorial approach. This was accomplished by flow-coating multiple films having different molecular masses and gradients in film thickness. Each "library," the size of a standard microscope slide, contains as many as 1500 differentiable experimental conditions, including process variables of temperature and time. Novel morphologies observed including a labyrinthine (or spinodal) surface patterns as well as extended smooth regions. These morphologies are related to an enthalpic vs entropic balance of interactions in block copolymers. In addition, the size of the surface patterns unexpectedly displayed an inverse relationship with molecular mass that can be attributed to the copolymer surface elasticity.

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BIOMIMETIC MEMBRANE STUDIES USING NEUTRON REFLECTOMETRY

Structures that serve as models of cell membranes are of fundamental importance in understanding such key biological processes as phospholipid self-assembly, molecular recognition and cell-protein interactions. Recent improvements in neutron reflectometry at the NIST Center for Neutron Research (NCNR), coupled with advances in biomimetic film fabrication at NIST, afford enhanced sensitivity for the study of membranes and membrane-protein complexes.

New phase-sensitive measurement techniques and model-independent data analysis methods developed at the NCNR have demonstrated the feasibility of obtaining reliable depth profiles of supported membranes in contact with biologically relevant aqueous environments, achieving subnanometer spatial resolutions.

Using these methods, the depth profile of a biomimetic membrane consisting of a self-assembled alkanethiol monolayer, anchored to a gold film, and a phospholipid layer self-assembled *in situ* from vesicles in solution has been measured. The results compare well with molecular dynamics simulations. The interaction of the peptide melittin with similar biomimetic films has also been probed, revealing that the small protein penetrates into the phospholipid leaflet of the film and perturbs the underlying alkane layer. Work using these advanced neutron capabilities is underway to study biomimetic films produced on engineered and cushioned surfaces which will enable the investigation of trans-membrane proteins.

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A SOFTWARE TOOL FOR GENERATION OF MONSEL LIBRARIES

A means of simulating electron trajectories and secondary generation in scanning electron microscope samples is an essential piece of the library-based linewidth measurement system being developed under contract with SEMATECH. The NIST code for doing this, called "MONSEL," has some important advantages compared to commercial codes. Developed at NIST, it adopts a more fundamental approach, simulating, for example, secondary electron trajectories in detail instead of treating them in an average way, and because of this a commercial code with free parameters may adjust those parameters in order to obtain agreement

with the MONSEL results. However, MONSEL lacks some of the convenience features present in commercial software. Particularly relevant for our library-based linewidth measurement system is the fact that MONSEL's inputs are in the form of files, which must be painstakingly edited for each of the hundreds of simulations that must be performed to generate a library. Accordingly, we have developed a new software tool that automatically: generates the input files required for each of the possible combinations of user-specified edge shape parameters; generates a batch file that runs MONSEL once for each such parameter combination and copies MONSEL's output file to a file with a unique name; and generates a directory of these file names and the shape parameters that are associated with them. The new tool was used to begin simulations for two new model libraries, one for an isolated polysilicon line and one for densely packed polysilicon lines, on four of NIST's high performance computers. The simulations are expected to require approximately a week on each of the four computers to complete.

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PROCEEDINGS OF THE WORKSHOP ON MEASUREMENT TRACEABILITY FOR CLINICAL LABORATORY TESTING AND IN VITRO DIAGNOSTIC TEST SYSTEMS

The Proceedings of the Workshop on Measurement Traceability for Clinical Laboratory Testing and In Vitro Diagnostic Test Systems is now available on CD in PDF format. This NIST-hosted workshop was held in November 2000 to address the standards needs of the clinical laboratory community in light of new international requirements. The workshop was cosponsored by several organizations having vested interest in developing a globally recognized clinical traceability infrastructure. This publication documents 10 talks given by national and international experts who provided the background and current status of the traceability structure for clinical laboratory measurements worldwide. It also includes the record of a candid discussion of issues and concerns as expressed by stakeholders and experts from around the world. There was general consensus among the 135 participants that healthcare is now more than ever a global issue and a global commodity, demanding global solutions. The sense of urgency, commitment, and dedication of these stakeholders is uniquely captured in this workshop record.

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NIST CO-SPONSORS IT ACCESSIBILITY 2001 CONFERENCE

NIST, along with with a private company and the Information Technology Association of America, co-sponsored the IT Accessibility 2001 Conference in May 2001, at NIST. The conference drew attendees from industry, federal and state government, advocacy groups, accessibility centers, and academia.

Speakers included accessibility experts, IT developers, research and standards experts, representatives from accessibility centers, and federal and state agencies. Presentations focused on current and future strategies for creating an environment with easy accessibility to information technology by people with disabilities. Government representatives for the U.S. Access Board, GSA, the Department of Justice, and the Department of Education addressed the federal Section 508 regulations requiring accessibility of IT by government agencies. Several web developers presented their experiences in designing accessible websites.

Exhibits and demonstrations supplemented the speaker program and helped provide attendees with an overview of available IT accessibility products and services. Exhibits covered a wide range of information appliances and services, including an accessible electronic voting machine, computer screen readers (which use speech synthesizers to "read" text and descriptions on a web page for visually impaired persons), and the NIST rotating Braille reader. A demonstration of near real-time closed-captioning of the webcasting of the presentations was provided and shown via webcast on a TV monitor in the conference auditorium.

The webcast of the conference are available at http://www.nist.gov/ITaccess2001.

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NIST HOSTS LARGE VOCABULARY CONVERSATIONAL SPEECH RECOGNITION WORKSHOP

NIST hosted the 2001 Workshop on Large Vocabulary Conversational Speech Recognition, in May 2001, in Linthicum, MD. Workshop participants reviewed the results of this year's evaluation conducted by the division in cooperation with DoD sponsors. Participating sites developed systems to automatically generate word-level transcriptions of recorded telephone conversations; these were scored against official reference transcriptions. Eight research groups from the United States and Europe participated in parts of the evaluation and discussed their work at the workshop.

This year's test set was the largest ever in size, involving 60 5-minute telephone conversations from three different corpora. One of these was the new Switchboard-Cellular Corpus, marking the first time evaluation has been done on cellular telephone data. NIST researchers presented an analysis of the evaluation results and compared these results to those of previous evaluations. Overall performance results of the best systems, measured by word error rate, were the best outcome ever achieved on the Switchboard-2 Corpus. As in recent years, the system achieving the lowest word error rates on each corpus this year was that developed by Cambridge University. As in the 2000 evaluation, a separate non-competitive evaluation was conducted on a subset of the test data, in which sites were asked to generate transcriptions at both the word and phonetic levels. Researchers at the International Computer Science Institute in Berkeley, CA analyzed the results, and the findings were presented at the workshop. The website is http://www.nist.gov/speech/tests/ctr/h5_2001/index.htm.

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NIST COLLABORATES WITH NEMI ON STANDARDS PROJECT FOR LEAD-FREE SOLDERS

Tin-lead (Sn-Pb) solder has been used extensively as an electrodeposited surface finish for component contacts/leads in the electronics industry because such coatings provide excellent solderability, ductility, electrical conductivity and corrosion resistance. The codeposition of Pb and Sn has been found to be effective in retarding Sn whisker growth and hence, has been the industry standard for over 20 years. In the absence of Pb, whiskers tend to grow spontaneously from electrodeposited Sn films, which can lead to electrical short circuits and device failure. Now that lead-free solder alloys have been introduced, electronic manufacturers are seeking a surface finish technology that will prevent Sn whisker growth without the use of Pb.

Researchers at NIST are working to identify the basic mechanisms of Sn whisker growth by systematically studying correlations between deposit microstructure, whisker formation and electrodeposition parameters. For example, Sn-Cu solder has been mentioned as a possible replacement for Sn-Pb; however the NIST team has recently found that the addition of Cu^{2+} to the Sn plating bath actually increases the probability and the speed at which whiskers form. Gaining a fundamental understanding of the whisker growth mechanism is required to help eliminate the problem and to develop a reliable test method for predicting whisker growth which the microelectronics industry requires. Towards this end, NIST is participating in a new National Electronics Manufacturing Initiative standards development project to help develop a robust test method for predicting whisker growth for industrial surface finish systems.

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Standard Reference Materials

NEW ABSOLUTE MAGNETIC MOMENT STANDARD REFERENCE MATERIAL FOR THE RECORDING INDUSTRY

A new Standard Reference Material (SRM) for use in calibrating the magnetometers used in the recording industry and research laboratories has been issued. Industry should find this SRM (SRM 762) more useful than the existing SRM (SRM 772a) because its geometry is similar to the sample shapes used for recording tape or hard disk samples, and it will eliminate the need for applying shape corrections for accurate measurements. Because the magnetic properties of metals depend on thermomechanical processing history and geometry as well as purity, the properties of the nickel disks used for this SRM were certified using the absolute magnetometer developed by NIST. The saturation moment of the new SRM (1.75 mAm^2 or 1.75 emu) is about half that of the old SRM which may be advantageous for some magnetometers. The new SRM is certified for applied fields between 280 kA/m and 4000 kA/m (3500 Oe and 50 000 Oe) and for temperatures between 280 K and 310 K.

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The International System of Units (SI)
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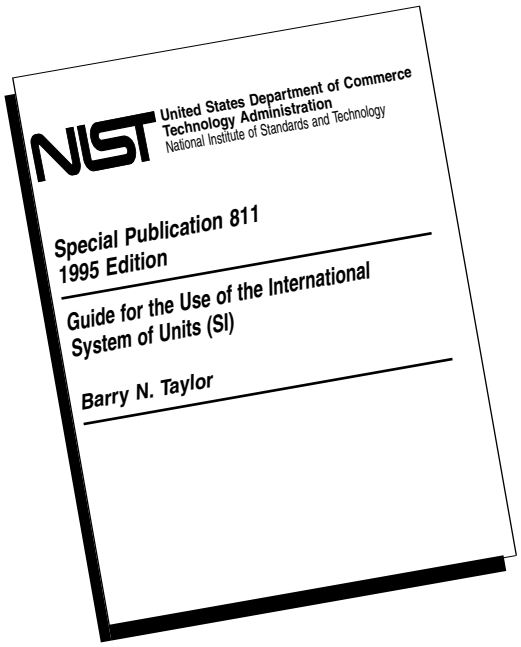

Uncertain about the International System of Units (universally abbreviated SI), the modern metric system used throughout the world? Do you need to know the proper way to express the results of measurements and the values of quantities in units of the SI? Do you need to know the NIST policy on the use of the SI? Then you need the 1995 edition of the National Institute of Standards and Technology Special Publication 811, *Guide for the Use of the International System of Units (SI)*.

The 1995 edition of the National Institute of Standards and Technology Special Publication 811, *Guide for the Use of the International System of Units (SI)*, by Barry N. Taylor, is now available.

The 1995 edition of SP 811 corrects a number of misprints in the 1991 edition, incorporates a significant amount of additional material intended to answer frequently asked questions concerning the SI and SI usage, and updates the bibliography. The added material includes a check list for reviewing the consistency of written documents with the SI. Some changes in format have also been made in an attempt to improve the ease of use of SP 811.

The topics covered by SP 811 include:

- NIST policy on the use of the SI in NIST publications.
- Classes of SI units, those SI derived units that have special names and symbols, and the SI prefixes that are used to form decimal multiples and submultiples of SI units.
- Those units outside the SI that may be used with the SI and those that may not.
- Rules and style conventions for printing and using quantity symbols, unit symbols, and prefix symbols, and for spelling unit names.
- Rules and style conventions for expressing the results of measurements and the values of quantities.
- Definitions of the SI base units.
- Conversion factors for converting values of quantities expressed in units that are mainly unacceptable for use with the SI to values expressed mainly in units of the SI.
- Rounding numbers and rounding converted numerical values of quantities.

Single copies of the 84-page SP 811 may be obtained from the NIST Calibration Program, 100 Bureau Dr., Building 820, Room 236, Stop 2330, Gaithersburg, MD 20899-2330, telephone: 301-975-2002, fax: 301-869-3548.

NIST Technical Publications

Periodical

Journal of Research of the National Institute of Standards and Technology—Reports NIST research and development in metrology and related fields of physical science, engineering, applied mathematics, statistics, biotechnology, and information technology. Papers cover a broad range of subjects, with major emphasis on measurement methodology and the basic technology underlying standardization. Also included from time to time are survey articles on topics closely related to the Institute's technical and scientific programs. Issued six times a year.

Nonperiodicals

Monographs—Major contributions to the technical literature on various subjects related to the Institute's scientific and technical activities.

Handbooks—Recommended codes of engineering and industrial practice (including safety codes) developed in cooperation with interested industries, professional organizations, and regulatory bodies.

Special Publications—Include proceedings of conferences sponsored by NIST, NIST annual reports, and other special publications appropriate to this grouping such as wall charts, pocket cards, and bibliographies.

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